Research Article

Comparative Performance Analysis of Bus Transport System in Context of Indian Cities

Jitendra Gurjar[1], Shivam Singh Chauhan[2]

Abstract

Bus transport system plays important role in reducing traffic congestion, air pollution, and road accidents. It is observed that bus transport system is decreasing day by day and experiencing exorbitant costs and low revenues in India. Most of the Indian cities faces various problems such as overcrowding, traffic congestion, higher level of air and noise pollution, inefficient and uneconomic public transport routes, irrational location of bus stops and schedule is not strictly adhered. Therefore, it is required to the Bus transport systems have placed increasing emphasis on improved management and better utilization of existing facilities. Hence, the major reasons for evaluating the comparative performance of bus system are to control cost, impact of bus service in a city and justify the alteration in bus service like speed, infrastructure facilities, no of buses, types of bus, no of bus stops, and changes along roadways and in land uses. Therefore, there is a need of a systematic approach for analysis of comparative performance of public transport system. However, a critical review of literature indicated that there is a lack of comprehensive techniques and methods which can be used for evaluating the comparative performance of bus transport systems. Hence this study presents a systematic approach for analysis of comparative performance of bus transport system in Indian cities. The proposed approach consists of mainly four stages. These stages are (i) A hierarchical structure for identification of comparative bus performance indicators (ii) Development of indices for analysis of condition of identified comparative bus performance indicators (iii) Determination of relative weight of identified comparative bus performance indicators (iv)Development of a composite comparative bus performance index (CCBPI). This study will be helpful for researchers to evaluate the comparative performance of any two bus transport system.

Keywords: Bus transport system, Comparative bus performance indicators, Performance analysis

Introduction

Bus transport plays a vital role in promoting economic growth and prosperity of a country. It is the important and primary way which is used by the public for safe, efficient, and economic transport without access to private vehicles. In India it is adopted for many purposes, such as providing mass mobility, reducing travel cost, reducing road congestion, mitigation air pollution, reducing energy and creating development opportunities. It is observed that mode share of Bus transport system is decreasing and experiencing financial problems caused by increasing transport demand and inadequate supply of public transit service thereby creating a huge economic loss and environmental degradation. Most of the Indian cities face various problems such as overcrowding, traffic congestion, higher level of air and noise pollution, inefficient and uneconomic public transport routes; irrational location of passenger stop and schedule is not strictly adhered. Dissatisfied bus transport users are progressively moving to the private vehicles for flexible, safe, convenient, and faster service. If these trends continue, it will be difficult for transit to effectively address these important social. Thus there is a great need to ensure that the public transit services are safe, efficient, affordable and effective. A critical literature review indicated that most of the research studies focused on evaluating the performance of Bus transport

[1]PhD Scholar and Assistant Professor (on Contract), [2]M.Tech Scholar, Department of Civil Engineering, Maulana Azad National Institute of Technology, Bhopal 462003, Madhya Pradesh, India.

Correspondence: Mr. Jitendra Gurjar, Department of Civil Engineering Maulana Azad National Institute of Technology, Bhopal 462003, Madhya Pradesh, India.

E-mail Id: Jiten.manit@gmail.com

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system. However, there is no comprehensive and common systematic approach and not adequate detailed research has been done to evaluate the comparative performance of Bus transport system in India cities. Further the most of the research methodology is not structured in a simple manner that makes it easily accessible to decision makers. Hence this study presents a systematic approach for analysis of comparative performance of Bus transport system in Indian cities. The proposed approach consists of four stages. These stages are (i) A hierarchical structure for identification of comparative bus performance indicators (ii) Evaluation of condition of identified comparative bus performance indicators (iii) Relative weight of identified comparative bus performance indicators (iv) Development of comparative analysis index. This paper consists of four sections of which this is the first one. The first section focuses problem statement, need of the study, and objective of the study. The second section highlighted literature review on analysis of Bus transport system. Third section presents a proposed approach for comparative performance analysis. The last section presents the important conclusions drawn from this study.

Literature Review

Literature review is carried out on various aspects of performance analysis of bus transport system. Roux YE et al (2011) discussed that bus transport system is poorly planned because the implementation of bus transport system is generally based on transport system of developed countries. However, the Bus transport system delivery environment differs between developed and developing countries like India. Mahmoud concluded that the selection of appropriate indicators is complicated tasks due to a variety of indicators are presented in the literature and the variation in their definitions.[8] Das S discussed that many performance indicators which might be significant in the developed countries might actually be irrelevant for the Indian context.[2] Jaiswal A et al. evaluated the impact of bus rapid transit system in Ahmadabad's city before and after implementation of bus rapid transit system in terms of traffic impacts, social impacts and environmental impacts.[7] Gandhi S et al. evaluated the comparative performance of BRTS in terms of Social, Passenger and operational indicators using sixteen identified design alternatives.[3] The results are then compared against current assumptions and theories around what comprises an 'ideal' BRTS. Government of Karnataka Tumkur city bus analysis report carried out the various issues contributing to inefficient operation of bus services need to be identified and appropriate techniques/ measures should be formulated to resolve these issues.[9] A literature review indicated that there is a lack of systematic approach for analysis of comparative performance of Bus transport system in Indian cities.

A Rational Approach for Analysis of Comparative Performance of Bus Transport

Comparative performance analysis of bus transport system gives a clear indication of how well it is providing bus service to the public in the area served in comparisons to other alternatives. Hence this study is presents a rational approach for analysis of comparative performance of bus transport system. Figure 1 presents the framework of proposed rational approach.

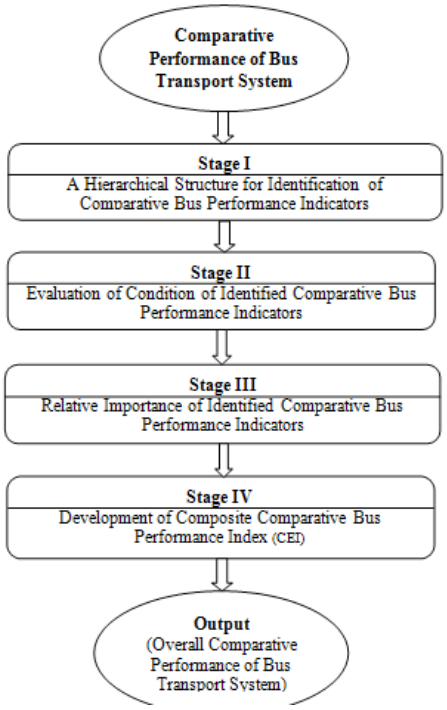

Figure 1.A Framework for comparative performance of bus transport system

The methodological framework comprises four major stages for performance analysis of public transport routes are as follows.

Stage I: A hierarchical structure for identification of comparative bus performance indicators

Stage II: Evaluation of condition of identified comparative bus performance indicators

Stage III: Relative importance of identified comparative bus performance indicators

Stage IV: Development of composite comparative bus performance index (CCBPI)

Stage I: A Hierarchical Structure for Identification of Comparative Bus Performance Indicators

The comparative bus performance indicators are management tool which gives a clear indication of comparative performance of bus transport system in served area. The selection of most appropriate comparative bus performance indicators based on Indian context is a rigorous process because a large number of indicators are available in literature. Therefore, the main objective of this stage is to develop a hierarchical structure for most appropriate set of comparative bus performance indicator for Indian context. Figure 1 presents a hierarchical structure for identification of comparative bus performance indicator. This study identified eight bus performance indicators for analysis of comparative performance of bus transport system.

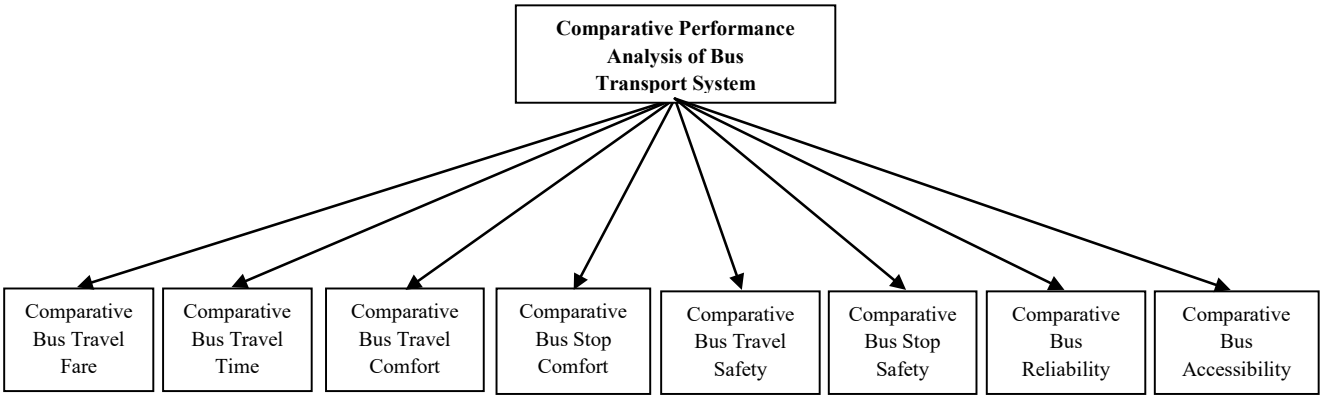

Figure 2.A hierarchical structure for identification of comparative bus performance indicator

Stage II: Evaluation of condition of identified comparative bus performance indicators

The second stage presents a methodology for analysis of condition of identified bus performance indicators. These indices are developed in such a way that comparative performance of bus transport systems can be evaluated in a city. Table 1 presents a methodology for analysis of condition of identified analysis indicators.

Table 1.A methodology for analysis of condition of identified analysis indicators

S. No.	Performance Measure	Methodology for Comparative Performance
1	Comparative Bus Travel Fare Index (CTTFI)	$\mathbf{CTTFI} = \frac{\mathbf{TFB_I}}{\mathbf{TFB_{II}}}$ TFB_i=Travel Fare of Bus transport system 'i' TFB_i=Travel Fare of Bus transport system 'i'
2	Comparative Bus Travel Time Index (CTTTI)	$\mathbf{CTTTI} = \frac{\mathbf{TTB_I}}{\mathbf{TTB_{II}}}$ TTB_i=Travel time of Bus transport system 'i' TTB_i=Travel time of Bus transport system 'ii'
3	Comparative Bus Travel Comfort Index (CBTCI)	$\mathbf{CBTCI} = \frac{\mathbf{TCB_I}}{\mathbf{TCB_{II}}}$ TCB_i= travel comfort rating of bus transport system 'i' TCB_{ii}= travel comfort rating of bus transport system 'ii' Rating value lies between 0 to 1 (Very poor to extremely comfort)
4	Comparative Bus Stop Comfort Index (CBSCI)	$\mathbf{CBSCI} = \frac{\mathbf{SCB_I}}{\mathbf{SCB_{II}}}$ SCB_i= Stop comfort rating of bus transport system 'i' SCB_{ii}= Stop comfort rating of bus transport system 'ii' Rating value lies between 0 to 1 (Very poor to extremely comfort)
5	Comparative Bus Travel Safety Index (CBTSI)	$\mathbf{CBTSI} = \frac{\mathbf{TSB_I}}{\mathbf{TSB_{II}}}$ TSB_i= travel safety rating of bus transport system 'i' TSB_{ii}= travel safety rating of bus transport system 'ii' Rating value lies between 0 to 1 (Very poor to extremely safety)
6	Comparative Bus Stop Safety Index(CBSSI)	$\mathbf{CBSSI} = \frac{\mathbf{SSB_I}}{\mathbf{SSB_{II}}}$ SSB_i= Stop safety rating of bus transport system 'i' SSB_{ii}= Stop safety rating of bus transport system 'ii' Rating value lies between 0 to 1 (Very poor to extremely safety)
7	Comparative Bus Reliability Index (CBRLI)	$\mathbf{CBRLI} = \frac{\mathbf{OTB_I}}{\mathbf{OTB_{II}}}$ OTB_i= On time Trips at stop of Bus transport system 'i' OTB_i= On time Trips at stop of Bus transport system 'ii'
8	Comparative Bus Availability Index (CBALI)	$\mathbf{CBALI} = \frac{\mathbf{TVB_I}}{\mathbf{TVB_{II}}}$ TVB_i= Total Vehicle available of Bus transport system 'i' in a city TVB_{ii}= Total Vehicle available of Bus transport system 'ii' in a city

Stage III: Relative weight of identified comparative bus performance indicators

The bus performance indicators may not equally affect the comparative performance of bus transport system. A system of weights therefore needs to be introduced to reflect the contribution to comparative performance of bus transport system. The relative importance of the identified bus performance indicators are determined by the expert opinion survey. Table 2 presents the relative importance of identified comparative bus performance indicators.

Table 2.Relative weight of comparative bus performance indicators

S No.	Comparative Bus Performance Indicators	Relative Weight
1	Comparative bus travel fare	0.248
2	Comparative bus travel time	0.198
3	Comparative bus travel comfort	0.092
4	Comparative bus stop comfort	0.061
5	Comparative bus travel safety	0.121
6	Comparative bus stop safety	0.080
7	Comparative bus reliability	0.110
8	Comparative bus accessibility	0.090
	Total	**1.000**

Stage IV: Development of composite comparative bus performance index (CCBPI)

The purpose of this stage is to develop a comparative analysis index (CCBPI) which can evaluate the overall performance of Bus transport system to private transport service. Comparative analysis index (CPI) developed by multiplication of relative weight and condition indices of analysis indicators.

$$CCBPI = W_{BTF} * CBTFI + W_{BTT} *CBTTI + W_{BTC} *CBTCI+ W_{BSC} *CBSCI + W_{BRL} *CBRLI + W_{BAL} *CBALI \quad \text{..... Eq. (1)}$$

Conclusions

The main objective of this study is to presents a systematic approach for analysis of comparative performance of bus transport system in Indian cities. Some of the important conclusions drawn from this study are as follows:

- A critical literature review indicated that most of the research studies focused on evaluating the performance of bus transport system. However, there is no comprehensive and common systematic approach and not adequate detailed research has been done to evaluate the comparative performance of Bus transport system in India cities. Further the most of the research methodology is not structured in a simple manner that makes it easily accessible to decision makers. Hence this study presents a systematic approach for analysis of comparative performance of bus transport system.
- The proposed approach consists of four stages. These stages are (i) A hierarchical structure for identification of comparative bus performance indicators (ii) Evaluation of condition of identified comparative bus performance indicators (iii) Relative weight of identified comparative bus performance indicators (iv)Development of composite comparative bus performance index (CCBPI).
- This study presents a hierarchical structure for identification of concise set of comparative bus performance indicators. This study identified eight comparative bus performance indicators for analysis of comparative performance of bus transport system. These are comparative bus travel fare, comparative bus travel time comparative bus travel comfort comparative bus stop comfort comparative bus travel safety comparative bus stop safety comparative bus reliability and comparative bus accessibility. Further, various performance indices are also developed in this study to evaluate the condition of identified comparative bus performance indicators. These indices can be used to evaluate the comparative performance of bus transport system in a city.
- This study also proposed relative weight of each identified comparative bus performance indicators. This study also presents the comparative performance index (CCBPI). CCBPI can developed using condition of identified bus performance indicators and their relative weight which is indicate the overall performance of bus transport system.

It is expected that this study will be useful to researchers for improving the performance of Bus transport system in India.

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